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A STUDY TO DEVELOP

A CASE MIX MANAGEMENT MODEL FOR COST EFFECTIVE ALLOCATION OF OUTPATIENT WORKLOAD BETWEEN MILITARY PHYSICIANS AND CONTRACT PHYSICIANS IN THE OBSTETRICS AND GYNECOLOGY CLINIC OF SILAS B. HAYS ARMY COMMUNITY HOSPITAL

A Graduate Research Project

Submitted to the Faculty of

Baylor University

In Partial Fulfillment of the

Requirements for the Degree

of

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by

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I. INTRODUCTION

Conditions Which Prompted the Study

The Obstetrics and Gynecology (OB-GYN) Clinic of Silas B. Hays Army Community Hospital provides a wide range of specialty health care to a population of approximately 34,351 female beneficiaries. The demand for outpatient care which this population places on the clinic has traditionally exceeded the clinic's appointment capability due to limitations on the amount of physician time available for outpatient care. This has led to long waits for appointments, encouraged inappropriate use of the emergency room, and generated dissatisfaction among the patients. To improve the access to care, the OB-GYN service considered an augmentation of their staff, either by hiring civilian physicians or by entering into a contractual arrangement with civilian physicians.

The opportunity to expand the OB-GYN staff was first presented in March 1985 as part of the Catchment Area Demonstration (CAD) Project, a Department of Defense test project for initiatives in military health care. The original scope of the CAD project granted the military hospital commander area management responsibility for both the military delivery system and for the services performed by civilian health care providers under the Civilian Health and Medical Plan of the Uniformed Services (CHAMPUS). An expanded OB-GYN Clinic offering evening and weekend appointments was among the clinical initiatives to be implemented under the CAD project.

Following a cancellation of CAD funding in late 1985, the Army Surgeon General's office maintained the concept of expanding OB-GYN outpatient services, incorporating this initiative as a specialty augmentation performed under civilian contract in one of two Primary Care for the Uniformed Services (PRIMIS) clinics to be established in the Fort Ord area. PRIMIS is a concept under which a civilian provider contracts with the government to operate an outpatient clinic. The method for determing payment to the PRIMIS contractor, and the delineation of professional responsibilities between the OB-GYN component of the PRIMIS clinic and the Silas B. Hays OB-GYN clinic, are flexible and can be specified by the hospital commander. The PRIMIS clinic and the OB-GYN component are scheduled for implementation in fiscal year 1988 with contract proposals to be offered and evaluated in fiscal year 1987.

The Problem Statement

The issues to be considered in developing a contractual OB-GYN augmentation are first, the extent to which the contractor will provide services in terms of both numbers of appointments and types of appointments. Secondly, the cost implications of the contract based on the method of reimbursement to be selected. Both considerations will affect the final cost of the contract, and both will affect the functioning of the hospital's OB-GYN clinic, which will remain in operation. If, for example, the contractor were to be paid an equal fee for all visits, he would have an incentive to concentrate on uncomplicated visits of short duration, and produce a greater volume of visits. At the same time, the existing OB-GYN clinic would, by default, be asked to provide more resource intensive visits. Therefore, the problem to be resolved in this project is to produce a workload allocation model which will consider both of these issues and can allocate the OB-GYN visits between OB-GYN clinic physicians and contractor physicians at minimum cost. The model must also allow the OB-GYN clinic staff to reserve certain types and amounts of visits for allocation to the clinic staff in order to maintain clinical proficiency and for teaching purposes.

Objectives

Objective One: The visits for the OB-GYN clinic will be classified into case-mix groups, each with a medically relevant basis, and each with a basis for consumption of physician time, and the cost if referred to a contract provider.

Objective Two: A measure of the monthly demand for OB-GYN appointments will be made. This will be conducted for a three-month period of time using existing sources of workload data, and a one-month period using a special effort of prospectively recording appointment requests.

Objective Three: The availability of time the staff physicians make available for appointments will be determined. This will be done for the same three-month period used to estimate demand.

Objective Four: The cost per visit of using contract physicians will be estimated based on a review of the fee for service claims data from CHAMPUS.

Objective Five: The preferences of the OB-GYN staff will be sought to ensure they are allocated sufficient variety of cases they feel are necessary to maintain clinical proficiency and discharge teaching duties.

Objective Six: A linear programing model (LPM) will be formulated to allocate demand for OB-GYN appointments between staff and contract physicians.

Criteria

Criteria One: When used with demand data for visits, manpower data for staff physicians and cost data for contracting, the model must be able to recommend the case-mix of staff and contractor workload resulting in the lowest cost. The case-mix allocation recommended by the model must demonstrate lower cost than simply referring all patients to a contract physician after appointments with the staff are filled.

Criteria Two: The model must be able to demonstrate the changes in case-mix and contract costs among different methods of reimbursement for contract services.

Criteria Three: The model must also be capable of performing simulations to determine the impact of changes in key variables, such as price, demand, and manpower.

Assumptions

Assumption One: Sufficient space and equipment will exist to allow for the addition of staff or contract physicians.

Assumption Two: Under the PRIMIS guidelines, contract physicians must meet the same standards of training, licensure, and competence as staff physicians, and can therefore be considered as able to perform the same work as staff physicans to the same standard of quality.

Assumption Three: The OB-GYN portion of the PRIMIS clinic will be located in a facility currently used as a military outpatient clinic, and it is assumed patients will accept treatment by the contract physicians as they do with staff physicians.

Assumption Four: It is also assumed that the contractor will allow the hospital to manage the case-mix of the appointments referred to the contractor.

Assumption Five: Reductions in the size of the present OB-GYN staff are not anticipated, and replacement of the staff physicians with contract physicians is not being considered.

Limiting Factors

Limitation One: Defining the OB-GYN workload to be performed was strongly influenced by the hospital's operating philosophy of seeing all patients who request treatment. Although a patient may have to wait for an appointment, the hospital does not attempt to determine the necessity of a patient's request for an appointment. The demand for service cannot, therefore, be examined in terms of necessary versus unnecessary care. The expressed demand of the patients for appointments is viewed as the demand to be satisfied.

Limitation Two: The options for shifting this demand to other hospital clinics is also restricted. The OB-GYN clinic does not restrict its operation to referrals from other providers; the hospital policy is to accept OB-GYN appointment requests from patients without requiring screening by a general medical clinic.

Limitation Three: Determining demand was also restricted by the Army's workload reporting system. Under current regulations, clinical workload represents visits for which both a demand was expressed and a resource supplied. In situations where resources are insufficient to meet the expressed demand, the unsatisfied demand is not required to be recorded. A retrospective look at unsatisfied demand is restricted to obtaining CHAMPUS data, which accounts for a portion of the demand by beneficiaries which is not satisfied by the clinic. A prospective recording of unmet demand could produce a more accurate historical record for defining workload, and was used to demonstrate a long-range solution towards implementing this project's solution.

Limitation Four: A new Chief of the OB-GYN Service was appointed in May 1986, and he is attempting to alter physician responsibilities to produce more time for clinic appointments. The extent to which his staff can perform more clinic work will affect the cost and extent of using contractual augmentation. The goal of the project, however, is not to develop a definitive cost estimate based on resources, demand, or prices at one point in time. This study's allocation model is designed to be a dynamic tool, and is meant to incorporate new values such as increases in staff resources for clinic appointments. The changing of staffing policies which are being considered should not affect the development of this study, but will be a factor in any implementation of the study's model.

Limitation Five: An assessment of the cost of providing treatment with staff physicians was not made. The Uniform Chart of Accounts (UCA) is the only calculation available which measures the cost of treating outpatients at military medical treatment facilities. This report is based on average costs, and does not employ differentiation of costs by case-mix. Staff assets were assumed to represent a fixed cost which would not be subject to reduction based on the cost of contracting. The limitation in the decision process for allocating work between contractor and staff physicians is, therefore, confined to the variable costs of supplies used by the staff. The model does not measure the impact of the staff's case-mix on the variable costs of supplies. Since the staff will continue to be allocated maximum work up to their available time, the staff's workload, and therefore supply costs, will not be replaced by the contractor. The supply costs of treatment by the staff were therefore considered fixed and a system of calculation was not devised.

Related Research

The term "case-mix" has become accepted in health care literature to denote the classification of treatments with respect to various criteria. The classification process is designed to organize the health care output into manageable products and product lines for reimbursement, planning, quality control, budgeting, and research purposes.[1] The case-mix situation in the OB-GYN study shares two areas of study with previous researchers: The use of a classification system for defining products, and the development of an approach to study and use the case-mix information to distribute workload in a manner which optimizes a specified value.

Concern over using health care costs stimulated researchers in the early 1970s to conduct studies of resource utilization and costs in providing inpatient care. Whether the researchers attempted to study health care delivery in one hospital, or to conduct comparative studies of several hospitals, they first had to develop a basis of measurement to standardize output data. Work on classifying treatments into groups was begun in order to reduce the thousands of combinations of diagnosis, procedures, and severity manifestations into data of a more manageable size. Output measures expressed as patient days and patient cases did not yield sufficient detail to explain variations in cost between hospitals. Much of the initial research was based on compiling groups based on diagnostic categories of the International Classification of Disease (ICDA). Evans and Walker took this approach to produce 98 groups based on ICDA and age/sex proportions.[2] Other researchers, such as Bays, incorporated age/sex categories and multiple diagnosis with the ICDA classification.[3]

The significance of this work in classifying workload and studying case-mix was shown by Zaretsky who demonstrated case-mix to be a highly important and statistically significant factor affecting hospital costs.[4] The linking of case-mix and costs foreshadowed the era of prospective reimbursement, and the necessity of employing case-mix management in hospital strategic planning. The most significant work leading towards this situation was the Yale University study resulting in the creation of Diagnostic Related Groups (DRGs). Fetter, and the other Yale researchers who devised DRGs, envisioned their DRG groups as a "manageable, medically interpretable set of case types that allows one to control for differences in complexity attributable to patient characteristics as described by age, primary diagnosis, secondary diagnosis, primary surgical procedure and secondary surgical procedure."[5] Fetter, et al, saw the use of their classification system to assist regional planners in defining the case-mix treatment responsibilities of area hospitals based on demand and resource consumption factors.[6] Fetter's assumption was that within resource limitations, access and quality constraints can be met with a number of alternative configurations of case-mix, with the least costly alternative preferred.[7] Furthermore, he recommended using linear programing techniques to suggest the most efficient distribution of case-mix configurations.[8]

The Social Securities Amendments of 1983 (Public Law 98-21, Title VI) established prospective payment for inpatient Medicare services, and used the DRG classifications as the basis for determining reimbursement. This legislation encouraged hospitals to adopt a product orientation in planning and budgeting, using the DRG classification to establish manageable product groups.[9] By 1984, at least 40 case-mix systems were available in the healthcare marketplace[10], although they were restricted to managing inpatient case-mix. Some systems were focused on short term requirements, such as assessing immediate effects of prospective payment, while more complex systems integrated costs, utilization reviews, clinical activities, and reimbursement, to guide organizational planning and budgeting.

The literature has detailed three case-mix models which resemble the model developed for the OB-GYN study. In the first of these, Goldfarb, et.al., described a nonlinear programing model with patients classified as necessary or discretionary.[11] Their objective was to maximize a nonlinear utility function based on the number of patients, case-mix, quality of service, and hospital income, constrained by available beds. Although a theoretical model, it is significant because it did not assume profit maximization as the sole objective. By incorporating trade-offs among various competing goals, both profit and policy related, Goldfarb, et.al., offered a planning model which recognized the multidimensional character of hospital decision making.

Baligh and Laughhunn also incorporated nonfinancial considerations when they developed a linear model for case-mix allocation.[12] Their objective was to maximize a weighted sum of a number of patients (classified by value to the hospital), subject to resource, patient, budgetary and policy constraints. Baligh and Laughhunn expressed a potential constraint as the minimum number of patients by class required to support teaching purposes. Other constraints such as goals for treating indigent patients were also presented. These noneconomic constraints influenced the value of the classes in the case-mix decision, and when combined with the economic constraints of resource consumption and budget, presented the hospital with a case-mix of optimum value which went beyond pure economic considerations.

The last linear programing model to be discussed was developed by Brandeau and Hopkins.[13] Their goal was to develop a linear programing model which could examine the monetary and resource effects of marginal changes in case-mix, and the financial impact of changes in reimbursement schemes by certain payers. To examine both of these issues, Brandeau and Hopkins classified their patients into 14 groups, based on DRGs, intensity levels, and payer groups. Their formulation was expressed as:

$$\max_{x} \sum_{j} (r_j - vc_j)\, x_j$$

subject to

$$\sum_{j} a_{ij}\, x_j = b_i$$

$$i = 1,2,\ldots,m.$$

and

$$dmin_j \leq x_j \leq dmax_j$$

$$j = 1,2,\ldots,n.$$

with the following variables:

j = index for classes of patients (by intensity and payer), $j = 1,2,\ldots,n$;

i = index for departments/services, $i = 1,2,\ldots,m$;

x_j = number of patients of type j;

a_{ij} = average number of units of service i used by group j patient.

$vc_j j$ = total variable cost incurred by patient of type j;

r_j = total revenue from patient of type j;

b_i = amount of service of i available;

$dmin_j$ = lower bound on demand for admission by patient type j.

$dmax_x$ = upper bound on demand for admission by patient type j.

This formulation is reproduced to illustrate linear programing considerations similar to that developed in the OB-GYN study. Brandeau and Hopkins' lower bound on patients (dmin) was developed to reflect the hospital's obligation to serve a given population, while the upper bound (dmax) represents the upper limit on patient demand. A similar bounding of demand was developed for the OB-GYN study to reflect requests for service (dmax) and requirements for teaching and clinical proficiency (dmin).

In a similar manner, this paper and the Brandeau and Hopkins study express the resource constraint of a department (b_is) with the understanding it is more of a policy variable than a fixed constraint.[14] Unlike the previous literature, the Brandeau and Hopkins model was implemented in a practical application. Stanford University Hospital used the model to negotiate Medicaid reimbursement levels in 1982, and to develop contract negotiation strategies with private insurance providers in 1982-83.[15]

The Brandeau and Hopkins linear programing case-mix model, similar to the one used in this paper, was shown to be a valuable tool in providing planners with financial impact projections of different reimbursement schemes. The effective use of such information was derived from employing such a model in competitive bidding for various case mixes.

Lessons from the Literature

The output of medical care has been expressed by the literature in terms of diagnosis, prognosis, utilization, organ system, hospital department, patient demographic characteristic, and method of reimbursement.[16] The selection of which of these criteria to employ in establishing case-mix groups should be guided by objectives.[17] Although this permits wide latitude in developing classification schemes, certain attributes have been considered important to any classification scheme:[18]

1. It must have clinical interpretability with relationships to diagnosis and operations.

2. Classes should be defined on variables commonly available on hospital abstracts, and revelant to output utilization.

3. The classes must be of a manageable number, and be mutually exclusive and exhaustive.

4. The classes should contain patients expected to utilize similar measures of output.

The case-mix management system using the classification should define the clinical outputs in terms of products, and should identify charges, statistics and costs associated with each product, identify the relationships between product mix and members of the medical staff, and facilitate involvement of the medical staff in planning, budgeting, and controlling health care operations.[19] The completed case-mix model should be able to perform a number of policy analyses using actual data and data hypothesized from future expectations.[20] The value of performing such functions has been demonstrated in reimbursement contracting using a model based on a linear programing formulation.[21] Thus far, publication of case-mix management research has been restricted to studies of inpatient treatment. The OB-GYN project will apply to the lessons learned in inpatient case-mix systems to develop an outpatient model capable of performing similar functions.

Project Methodology

The methodology is divided into three main areas: data collection, formulation of a linear programing model for case-mix allocation, and management applications. In the data collection phase, a determination of the case-mix groups and the patient demand within these groups will be presented. This will be followed by an examination of the OB-GYN staff resources which can be applied towards meeting the demand for service. The resource examination discussion will include consumption of physician time in providing care, the physician time available for providing care, and the policy guidelines which prioritize the application of the available physician time. The final data collection area to be presented is the cost of comparable services in the civilian community.

The formulation of the allocation model will describe the relationships among the relevant data variables described in the data collection phase. This will be followed by development of an objective function which will be formulated to result in the minimum cost of using contract physicians to meet the patient demand. The patient demand, unit costs of contracting, minimum staff workload, and staff physician resources will be used as constraints for the model.

The final portion of the discussion, management applications, will show how the model can be applied to compare alternative policies for contracting and using staff resources. A concluding section will summarize the potential value of implementing the model.

II. DISCUSSION

Data Collection

Case-Mix Groups. Prior to the collection of any data on the demand for OB-GYN outpatient services, a framework had to be developed within which the requests for this service could be classified and measured. This classification framework had to serve the patient by allowing an effective means to express the nature of the service requested, and had to assist the clinic by indicating the resources required to satisfy the request. A classification system to meet these needs was developed and implemented in the OB-GYN clinic in 1984 as part of the Computerized Medical Record Information System (CMRIS), a test project for automating clinical information. All OB-GYN visits were classified into one of the following nine groups, each with an assigned length of appointment time:

Group Number	Diagnostic Group	Abbreviation	Time Allocated Per Visit
1	PAP Smears	PAP	15 min.
2	New Obstetrical	NOB	20 min.
3	Routine Obstetrical	ROB	10 min.
4	Routine Gynecological	GYN	20 min.
5	Postpartum/Postoperative	PPV	15 min.
6	Colposcopy	CPC	30 min.
7	Ultrasound	UL	20 min.
8	Complicated Obstetrical	COB	20 min.
9	Histosalpingogram	HSG	30 min.

The groupings and time allocations represented above were the result of actual experience of the OB-GYN staff over the past four years. Both clinical interpretability (to include mutally exclusive and exhaustive classifying), and resource utilization (consumption of clinic time per visit) were considered in developing the groups. In the opinion of the OB-GYN staff, the time allocated per visit has been an accurate representation of the actual time employed. Nine groups of visits also represented a manageable size with which to plan the allocation of physician time, and identify the demands of the patients.

Establishing Total Demand for Service

While CMRIS could provide data on the number of visits by group, this workload would only express the demand for services which was satisfied. A projection of the total demand for the OB-GYN clinic needed to include those visits would have been made if additional appointments had been available.

The first PRIMIS clinic in Fairfax, Virginia, unsuccessfully attempted to predict the total demand for general outpatient visits whith a demographic approach.[23] Predicted usage was forecast from both national usage per capita, and from per capita utilization of military medical facilities. In practice, the first PRIMIS clinic saw 40% to 50% more visits than demographically predicted.[24] To improve the accuracy of workload predictions, two alternative approaches to measuring current demand were tried for the OB-GYN study: Historical data contained in CHAMPUS claims, and a prospective recording of requests for OB-GYN appointments.

Demand Satisfied by CHAMPUS

A computerized search of 1985 CHAMPUS claims data for the Fort Ord area was conducted to identify the extent to which the demand for outpatient GYN care was being met by local civilian providers. Procedure codes of the Physicians' Current Procedural Terminology, Fourth Edition (CPT-4) were used to sort the claims data into the case-mix groups used by the OB-GYN clinic for appointment scheduling. Providers are required to use the CPT-4 system to assign codes to visits as part of the CHAMPUS claims submission process. Using this approach, a total of 864 CHAMPUS outpatient GYN visits were identified for 1985. Obstetrical visits were not identified because CHAMPUS considers prenatal, postnatal and the inpatient portion of an obstetrical episode to be one inpatient service. Individual outpatient visits for obstetrical care are not authorized for separate reimbursement, and are not recorded in the CHAMPUS database except for an occasional outpatient emergency visit.

Table 1 displays the results of the CHAMPUS claims search. Annual demand for visits satisfied through CHAMPUS was further specified for a three-month period of the fall for more detailed study. Fall was selected for more detailed study because it is a time of year when the military population is usually stable. The number of visits shown in Table 1 represented all claims which had been made as of March 26, 1986, which allowed a minimum of almost four months with which to account for pending claims. The number of visits in 1984 for these months is also shown to indicate the extent to which a delay in submitting claims may result in an understatement of the CHAMPUS visits. With the exception of October and November GYN visits, the difference in 1984 and 1985 claims for these months did not indicate a large difference in the number of CHAMPUS visits.

FT ORD AREA
OUTPATIENT OB-GYN CHAMPUS WORKLOAD

Type of Visit		Number of Visits		
	Sep	Oct	Nov	1985, All Months
PAP (1985)	5	12	7	226
(1984)	26	22	18	
GYN (1985)	52	48	18	561
(1984)	60	81	62	
CPC (1985)	3	1	1	15
(1984)	4	2	4	
UL (1985)	6	2	0	58
(1984)	1	4	0	
HSG (1985)	0	0	0	4
(1984)	1	2	1	

Table 1

Comparison of 1984 and 1985 data suggests claim submission delays would not account for the low number of visits reported in Table 1. To see if the CHAMPUS claims in general are a low indicator of unmet demand by the OB-GYN clinic, CHAMPUS claims for care provided in November 1985 were selected for comparison with a prospective study of the OB-GYN clinic requests during the same month.

Prospective Demand Measurement. All requests for OB-GYN appointments received in November 1985 were recorded by the OB-GYN clinic appointment clerks on a prospective basis, and were recorded irrespective of whether an appointment was available or not. At the conclusion of the month, the number of OB-GYN appointments available was compiled from the clinic's daily schedule, and subtracted from the number of appointment requests.

The resulting workload is shown in Table 2. In two cases, UL and HSG visits, a surplus of available appointments is shown. This occurred because the appointments scheduled for these procedures were based on requests received in earlier months. Had the clinic schedule been made to satisfy demand expressed in November, clinic policy would have allocated surplus time to new obstetrical and complicated obstetrical visits. The adjusted unmet demand row of Table 2 reflects this redistribution and indicates the demand for visits expressed in November, which were not able to be satisfied by the available appointments.

NOVEMBER 1985 OB-GYN CLINIC VISITS

	PAP	NOB	ROB	GYN	PPV	CPC	UL	COB	HSG
Visits Requested	824	292	1020	796	288	69	13	614	5
Visits Available	78	131	596	31	49	28	149	11	11
Unmet Demand	746	161	424	765	239	41	0	603	0
Adjusted Unmet Demand	746	88	424	765	239	41	0	531	0
Nov 85 CHAMPUS Visits	7	0	0	18	0	1	0	0	0

Table 2.

Selection of Total Demand Data. Table 2 indicates that CHAMPUS claims represent a small fraction of workload which the OB-GYN clinic does not satisfy. CHAMPUS claims data did not, therefore, offer an accurate prediction of the workload the OB-GYN clinic would produce if resources for additional appointments had been provided. The CHAMPUS data may be too conservative for a variety of reasons: Failure to report visits not exceeding the annual deductible fee; use of other insurance plans by the patient; or ignorance of CHAMPUS procedures on the part of the patient. Prospective recording of appointment requests was a more accurate measure because it did not assume the patient's behavior or motivation for choosing where to receive care. The drawback of the prospective method is the possibility of recording repetitive requests from the same patient for obtaining a single appointment. Although this limitation is recognized, the prospectively determined total demand presented in Table 2 represents the most accurate data available, and will therefore be used in formulating and testing the study's allocation model.

Staff Resources. A listing of available OB-GYN clinic appointments for September, October and November 1985 was obtained from the CMRIS daily scheduling report. The staff physician resources available, expressed in minutes, were obtained by multiplying the number of available appointments by the time allocated per appointment. The results of these computations, shown in Table 3, indicates over a 50% reduction in clinic time from September to November. The variation in time allocated to clinic appointments was due to differences in inpatient workload, the use of compensatory time off by the physicians, and by the presence of holidays. Such circumstances make the prediction of an "average" month's work difficult to establish. More realistically, short range planning would consider factors such as these, and plan for supplemental coverage under the augmentation contract. Three months worth of resource data was obtained for use in studying the impact of various staffing levels such as these on the costs and use of contractual augmentation of the clinic.

AVAILABLE STAFF PHYSICIAN TIME FOR THE OB-GYN CLINIC

TYPE APPT	PAP	NOB	ROB	GYN	PPV	CPC	UL	COB	HSC	TOTAL TIME AVAILABLE
TIME PER APPT (min)	15	20	10	20	15	30	20	20	30	
Sep 85 Appt Avail	218	236	1075	672	112	72	21	277	5	
Time Avail	3270	4720	10750	13440	1680	2160	420	5540	100	47300 min.
Oct 85 Appt Avail	160	164	730	456	78	50	16	191	5	
Time Avail	2400	3280	7300	9120	1170	1500	320	3820	100	29010 min.
Nov 85 Appt Avail	78	131	596	300	31	49	28	149	11	
Time Avail	1170	2620	5960	6000	465	1770	560	2980	330	21835 min.

Table 3.

The final aspect of utilization of physician resources is the prioritization of services provided. The OB-GYN clinic policy is to give greater emphasis to obstetrical care and those gynecological conditions which could lead to inpatient treatment. This general policy, however, must also provide for some care by the staff in all types of OB-GYN appointments in order to ensure clinical proficiency is maintained and for the training of physician residents. With a contractual augmentation, the staff physicians gain greater flexibility in diversifying the type of patients they may see. Under the PRIMIS concept, the professional qualifications of contract physicians and the care they provide must meet the standards of Army regulations, the Joint Commission on Accreditation of Hospitals, and national professional standards. With these prerequisites, an assumption can be made that the contractor can be used in lieu of staff physicians for any OB-GYN appointment offered by the clinic. The guidelines for allocating workload between contractor and staff physicians were based on the cost of using contract physicians and the desires of the staff physicians to see a minimum number of appointments in the various case-mix groups. As an initial guide, the OB-GYN staff expressed a desire to see the following monthly minimum workload with staff physicians:

Type of Appointment	Desired Minimum Staff Appointments/Month
PAP	50
NOB	80
ROB	400
GYN	200
PPV	20
CPC	49
UL	7
COB	149
HSG	5

The diversity expressed by the minimum number of cases can also be altered to shape the nature of the clinic's scope of services, to take advantage of improvements in technology, or to take advantage of additional staff physicians.

Cost Alternatives. Two sources of additional physician resources were considered for use in augmenting the OB-GYN clinic's staff: permanent government service (GS) employed physicians and civilian physicians contracted to provide specified services. The GS authorization for additional physicians would be GS-14, step 1, and based on an annual salary of $59,010, and adding 10% for government paid benefits, the monthly cost of each additional GS physician would be $4,917.

There are three methods upon which the cost of contract physicians were calculated: The traditional fee for service, a set hourly rate for labor, and a set fee per visit. All three methods are being used in the civilian healthcare market, and any one of the three could be selected as the preferred reimbursement method for the contract to augment the OB-GYN clinic. Table 4 shows the unit costs of the traditional fee for service arrangement based on 1985 CHAMPUS claims for the Fort Ord area. Since obstetrical care is not reimbursed by CHAMPUS on a per visit basis, estimations of the unit cost for obstetrical visits were made using GYN visits of comparable length: PAP approximating ROB and PPV visits, and GYN approximating NOB and COB visits. The second basis for contract reimbursement, hourly rate for labor, is displayed in Table 5. Two hourly rates were used to calculate unit costs based on the number of visits possible in an hour, using the OB-GYN clinic's allocation time for appointments. The rates selected for illustration are ones commonly used in the local civilian community for staffing of acute care facilities. The final method, common fixed price for all visits, is the method employed in the PRIMIS clinic established in Fairfax, Virginia. The PRIMIS project officer for the Army Surgeon General's Office has estimated that the per visit cost in a PRIMIS clinic at Fort Ord would be $50.14.[25] This reimbursement method does not differentiate the length or complexity of a visit in determining reimbursement. Contractors assume the profit on some visits will offset the losses on others.

Formulation of the Allocation Model

Specification of the Variables

This model was developed to examine a series of alternative configurations of case-mix allocations between staff and contract physicians, and within resource limitations, to produce the least costly alternative. The model variables developed for use in formulating the model are:

1985 CHAMPUS UNIT COSTS, FORT ORD AREA

Type Visit	Average Fee for Service	Number of Visits	Standard Deviation	Maximum Fee	Minimum Fee
PAP	$10	226	$ 3	$ 26	$ 4
NOB	43	-	-	-	-
ROB	10	-	-	-	-
GYN	43	561	25	190	10
PPV	10	-	-	-	-
CPC	76	23	20	100	48
UL	87	49	52	163	25
COB	43	-	-	-	-
HSG	98	5	49	150	55

Table 4.

OB-GYN UNIT COSTS BASED ON HOURLY CHARGES

Type Visit	Unit Cost @ $100 Hr	Unit Cost @ $150 Hr
PAP	$25	$38
NOB	33	50
ROB	17	25
GYN	33	50
PPU	25	38
CPC	50	75
UL	33	50
COB	33	50
HSG	50	75

Table 5.

C = Total cost of visits performed by contract physicians in the period studied.

S = Savings realized by performing care with staff resources.

d_i = Total demand for appointments for group_i during the period studied.

t_i = Amount of physician time allocated per visit for group_i.

y_i = Number of visits in group_i allocated to the staff to be performed in the period examined.

m_i = Minimum number of visits in group_i which the staff desires to perform in the period examined.

T = Total number of minutes of staff time available for clinic use in the period examined.

C_i = Unit cost per group_i visit referred to a contract physician.

The Objective Function

The objective of the clinic is to meet the demand for visits by employing its staff in a manner which makes the least expensive use of contract physicians. This is stated:

$$\text{MIN} \quad C = \sum_{i=1}^{9} C_i \, (d_i - y_i)$$

Stating the objective function in this manner directly conveys the thrust of the model: To favor the allocation of work to the staff, resulting in minimizing of the contract cost. Although clearly indicating the model's purpose, this formulation does not directly state the number of contractor visits, but produces this value by an additional step of subtracting staff work from demand. This results in a very long objective function when the actual values are inserted and the computations are begun for obtaining a solution. The mathematical efficiency of the model was improved by restating the objective function as:

$$\text{MAX} \quad S = \sum_{i=1}^{9} C_i \, y_i$$

Expressing the objective function as a savings maximizer is the equivalent of expressing a cost minimizer, but offers a formulation which is more efficiently manipulated because it eliminates a subtraction process which indirectly defines the number of contractor visits.

Constraints

The availability of staff time for the clinic, the minimum work for the staff's proficiency and training, and the number of visits requested (total demand), constrained the model's solution. The objective function was therefore constrained:

$$\text{subject to:} \quad m_i \leq y_i \leq d_i$$

$$\text{and} \quad \sum_{i=1}^{9} t_i \, y_i \leq T$$

The Completed Formulation

The formulation for solution, using fee for service cost coefficients, November 1985 resource and demand variables, and the minimum workload requested by the staff, is expressed:

MAX S = 10Yi + 43Y2 + 10Y3 + 43Y4 + 10Y5 + 6Y6 + 87Y7 + 43Y8 + 98Y9

(Coefficients indicate cost per case referred to)
(Contractors)

$$\text{SUBJECT TO:} \quad \left.\begin{array}{l} Y1 \geq 50 \\ Y2 \geq 80 \\ Y3 \geq 400 \\ Y4 \geq 200 \\ Y5 \geq 20 \\ Y6 \geq 49 \\ Y7 \geq 8 \\ Y8 \geq 254 \\ Y9 \geq 5 \end{array}\right] \text{— Minimum Staff Work Constraints}$$

$$\left.\begin{array}{l} Y1 \leq 824 \\ Y2 \leq 292 \\ Y3 \leq 1020 \\ Y4 \leq 796 \\ Y5 \leq 288 \\ Y6 \leq 69 \\ Y7 \leq 13 \\ Y8 \leq 614 \\ Y9 \leq 5 \end{array}\right] \text{—— Demand Constraint: Number of Appointments to be provided}$$

$15Y1 + 20Y2 + 10Y3 + 20Y4 + 15Y5 + 30Y6 + 20Y7 + 20Y8 + 30Y9 \leq 21853$ (Resource Consumption per visit and Total Staff Time Availability Constraint)

The Y_i variables represent workload performed by staff physiciansfor the following groups: Y1 (PAP), Y2 (NOB), Y3 (ROB), Y4 (GYN), Y5 (PPV), Y6 (CPC), Y7 (UL), Y8 (COB), and Y9 (HSG).

Management Applications

Linear Programing Allocations. The solutions to the model's equations were arrived at using an IBM personal computer running LINDO (Linear, Interactive, Discrete Optimizer), a commercially available computer program for solving linear, integer, and quadratic problems.

Before presenting any linear programing solutions for discussion, however, the value of case-mix management must first be established. To do this, the OB-GYN clinic demand data for November 1985, presented earlier in Table 2, was used to calculate the cost of referring the unsatisfied appointment requests for that month to the contract physicians. No attempt was made to alter the types of appointments which the OB-GYN clinic had scheduled. The costs of referring workload without altering the nature of the OB-GYN clinic practice is shown in Table 6. Costs were calculated for the three methods of reimbursing contractors discussed earlier. The Linear Programing Model (LPM) was then used to run the same data and determine the extent to which the model's recommended allocation could

NOV 85 OB-GYN DEMAND WITHOUT LINEAR PROGRAMING ALLOCATION OF APPOINTMENTS

	Average Fee for Service Contract			$100 Hourly Contract			Flat Fee $50.14 per Visit Contract		
Case-Mix Group	Staff Appts	Contractor Appts	Contract Costs	Staff Appts	Contractor Appts	Contract Costs	Staff Appts	Contractor Appts	Contract Costs
PAP	78	746	$7460	78	746	$18650	78	746	$37404.44
NOB	204	88	3784	204	88	2909	204	88	4412.32
ROB	596	424	4240	596	424	7208	596	424	21259.36
GYN	31	765	32899	31	765	25245	31	765	38357.10
PPV	49	239	2390	49	239	5975	49	239	11983.46
CPC	28	41	3116	28	41	2050	28	41	2055.74
UL	13	0	0	13	0	0	13	0	0
COB	83	531	22833	83	531	17523	83	531	26624.34
HSG	5	0	0	5	0	0	5	0	0
Total Costs			$130603			$79555			$142096.76

Table 6.

more efficiently employ the OB-GYN clinic resources and reduce contract costs. The LPM simulations were successful in allocating the total demand while still meeting the OB-GYN staff's requirement for diversity of work. Appendices C, D and E contain the actual simulation results of this examination, and the results are summarized in Table 7. In a cost comparison of the LPM and non LPM allocations (Table 8), the LPM produced a less costly case mix than the nonprogramed approach for all of the reimbursement options. With cost reductions of 14.5%, 13% and 54% over the nonprogramed case-mix allocation, the LPM could produce significant savings if adopted for use in managing the clinic and contractor's case-mix. Having demonstrated the LPM as a potentially valuable approach in recommending case-mix allocations, the model was used to address some of the management questions which were alluded to earlier.

Comparison of Reimbursement Options. In Table 8, the LPM showed it could be used to calculate the cost of different reimbursement methods, given the most cost efficient case-mix per method. While this is certainly a major consideration in establishing an augmentation contract, the demonstration of the model was not made using prices offered by potential contractors. When the offer to bid on the contract is issued in 1987, the proposal offer could ask potential contractors to submit bids under any or all of the reimbursement methods. The first advantage of using the LPM in such a circumstance is to quickly calculate the expected costs of the various prices and reimbursement methods submitted by the bidders.

If Table 8 is examined more closely, another advantage of the LPM can be seen. Recommendations to select the least costly reimbursement method differ between the LPM and nonprogramed allocation approaches. This occurs because if the LPM is used to evaluate the cost of contract proposals,

NOV 85 OB-GYN DEMAND ALLOCATED BY LINEAR PROGRAMING

Case-Mix Group	Fee for Service Contract			$100 Hourly Contract			Flat Fee $50.14 per Visit		
	Staff Appts	Contractor Appts	Contract Costs	Staff Appts	Contractor Appts	Contract Costs	Staff Appts	Contractor Appts	Contract Costs
PAP	5C	774	$ 7740	50	774	$ 19350	50	774	$ 38808.36
NOB	262	30	1290	80	212	6996	80	212	10629.68
ROB	400	620	6200	834	186	3162	832	188	9426.32
GYN	200	596	25628	200	596	19668	200	596	29883.44
PPV	20	268	2680	29	268	6700	20	268	13437.52
CPC	69	0	0	49	20	1000	49	20	1002.80
UL	13	0	0	8	5	165	8	5	250.70
COB	254	360	15480	254	360	11880	254	360	18050.40
HSG	5	0	0	5	0	0	5	0	0
Total Costs			$ 59018			$ 68921			$121489.22

Table 7.

COST COMPARISON OF LINEAR PROGRAMING MODEL AND NONPROGRAMED CASE-MIX ALLOCATIONS FOR NOV 85 OB-GYN DEMAND

Reimbursement Method	Contract Costs Nonprogramed Allocation	Contract Costs LPM Allocation	LPM Cost Reduction
Average Fee for Service Contract	$130,603	$ 59,018	54%
$100 Hourly Rate Contract	$ 79,555	$ 68,921	13%
Flat Fee, $50.14 Per Visit Contract	$142,097	$121,489	14.5%

Table 8.

it can incorporate changes in staff utilization as part of the cost calculations. Without such a process, the contractor's case-mix at the proposed prices cannot be evaluated for cost reduction except for changing the proposed prices, or roughly estimating possible reductions which could be made in some of the referred work. Thus, beyond a single comparison of reimbursement proposals, the LPM allows managers an opportunity to search for areas to reduce the cost of proposed contracts which exceed the augmentation budget.

Increasing Staff Productivity. The basic assumption in considering a contract for additional resources is that the demand exceeds the manpower resources the OB-GYN clinic staff has available. The extent to which the contractor is used varies directly with the amount of time the OB-GYN staff can devote to the clinic. In the earlier discussion on staff resources, large fluctuations in staff availability were displayed in Table 3. Staff fluctuations can sometimes be predicted, such as vacations planned during holiday seasons, or the reduction in inpatient duties caused by renovation of the operating rooms. In such cases, management would desire to assess the impact of additional or reduced staffing on the budget for the contractual augmentation. To examine the LPM's usefulness in this application, the previously described simulations run with November 1985 data were re-run using the 47,300 minutes of staff time available in September 1985 in lieu of the 21,835 minutes available in November 1985. The simulations contained in Appendices F, G, H and summarized in Table 9 again displayed the model's ability to provide the inpact on contract costs and case-mix when staff resources change.

Another staffing application of the model is to simulate the results if the clinic staff were augmented by a combination of contract physicians and additional civilian employee physicians. To demonstrate this, the November 1985 demand and resources were again used as the basic data. In this simulation, the staff resource time was increased to 39,133 minutes, which reflects the addition of two Full-Time Employee (FTE) Physicians working an eight hour day. The LPM was run (Appendices I, J, K) to see the cost differences between the combined augmentation approach and an augmentation dependent solely on contract physicians. The results, presented in Table 10, shows the cost of contractors, the cost of additional FTEs (based on the GS-13 salaries discussed earlier), and the total cost of the combined augmentationfor each of the three reimbursement methods. For comparative purposes, the costs of augmenting with contract physicians alone was reproduced from Table 7, and placed below the combined augmentation costs. The LPM has, therefore, shown its ability to compare the costs of using additional staff resources with contract resources in both an either/or situation, and in combination.

Sensitivity Analysis. The accuracy of the LPM forecasts and recommendations depend on the accuracy of the data entered into the model. In the

NOV 86 OB-GYN CASE-MIX ALLOCATED BY LPM
ASSUMING SEP 86 STAFF RESOURCES

Case Mix Group	Fee for Service Contract			$100 Hourly Contract			Flat Fee $50.14 per Visit		
	Staff Appts	Contractor Appts	Contract Cost	Staff Appts	Contractor Appts	Contract Costs	Staff Appts	Contractor Appts	Contract Costs
PAP	50	774	$ 7740	824	0	$ 0	824	0	$ 0
NOB	292	0	0	80	212	6996	80	212	10629.68
ROB	973	47	470	1020	0	0	1020	0	0
GYN	796	0	0	203	593	19569	233	563	28228.82
PPV	20	268	2680	288	0	0	288	0	0
CPC	69	0	0	69	0	0	49	20	1002.8
UL	13	0	0	13	0	0	13	0	0
COB	614	0	0	614	0	0	614	0	0
HSG	5	0	0	5	0	0	5	0	0
Total Costs			$10890			$26565			$39861.3

Table 9.

NOV 85 OB-GYN LPM CASE-MIX ASSUMING NOV 85 STAFF RESOURCES AND
TWO ADDITIONAL FULL-TIME EMPLOYEES (FTE)

	Ave Fee for Svc			$100 Hourly Contract			Flat Fee $50.14 per Visit		
Case Mix Group	Staff Appts	Contractor Appts	Contract Cost	Staff Appts	Contractor Appts	Contract Cost	Staff Appts	Contractor Appts	Contract Costs
PAP	50	744	$ 7440	'24	0	$ 0	824	0	$ 0
NOB	292	0	0	80	212	6996	80	212	10629
ROB	400	620	6200	1020	0	0	1020	0	0
GYN	674	122	5246	200	596	19668	200	596	29883
PPV	20	268	2680	234	54	1350	274	14	702
CPC	69	0	0	69	0	0	49	20	1003
UL	13	0	0	8	5	165	8	5	250
COB	614	0	0	254	360	11880	254	360	18050
HSG	5	0	0	5	0	0	5	0	0
Total Contract Cost			$21566			$40054			$60517
FTE Cost			9834			9834			9834
Combined Augmentation Total Cost			$31400			$49888			$70351
Cost of Contractors Alone			$59018			$68921			$121489

Table 10.

simulations previously presented, the model was used to demonstrate how it could predict the outcome of various conditions which management might foresee occurring. A sensitivity analysis of the model's results was also conducted to demonstrate the degree of error which would be acceptable before the case-mix allocation would be altered.

The LINDO program was used to perform a sensitivity analysis of all of the coefficients of the model's variables in each of the simulations which were run, and the results were made a part of the appendices containing the simulation solutions. Table 11 was constructed to show the usefulness of conducting an analysis, using demand coefficients. The allowable increases shown in the table indicate the extent to which the demand can increase before the case-mix of the work allocated to the staff would change. Underestimation of the demand would have no impact on the case-mix allocations for the staff in 6 of the 9 case-mix groups showing increase to INFINITY. In the remaining 3, the estimation error would have to be large before a change occurred. If fewer requests for appointments are made than expected, the allowable decrease column indicates the point at which the expected demand can be reduced before it reaches the minimum work the staff wishes to perform, or the point at which a recalculation of the case-mix would be required. Use of the sensitivity analysis indicated the parameters within which the error of estimating correct values would alter the solution. If it is not likely that the allowable changes will be reached, the LPM allocation can be implemented. In cases where it is reasonably expected that actual practice will exceed the allowable values, additional simulations can be run to forecast the impact if these limits are exceeded.

SENSITIVITY ANALYSIS OF DEMAND FOR NOV 85
OB-GYN LPM CASE-MIX ALLOCATIONS

Case-Mix Group	Variable	Current Coefficient (Demand)	Allowable Increase	Allowable Decrease	Staff Appts Allocated	Staff Minimum Workload
PAP	Y1	824	Infinity	774	50	50
NOB	Y2	292	Infinity	30	262	80
ROB	Y3	1020	Infinity	620	400	400
GYN	Y4	796	Infinity	596	200	200
PPV	Y5	288	Infinity	268	20	20
CPC	Y6	69	121	20	69	49
UL	Y7	13	182	5	13	8
COB	Y8	614	Infinity	360	254	254
HSG	Y9	5	121	0	5	5

Table 11.

III. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

A linear programing model was developed which allocated workload of the OB-GYN clinic between staff physicians and contract physicians. The allocation was made by managing a case-mix of the various types of visits to produce a recommended mix which incurred the least cost to the government. The model considered the availability of the staff physicians' time, the consumption of time per visit, minimum work needed for clinical proficiency, and the cost of referring visits to a contractor. The model was demonstrated as a tool to be used in evaluating the cost of various reimbursement options which could be proposed under an augmentation contract. Finally, the model was shown to demonstrate various changes in cost and workload which would result if prices, staffing, or demand were altered.

Results which were produced by using the model were compared with the results of nonprogramed case-mix allocations, and were shown to be more cost-efficient. The model was, therefore, shown to be a valuable tool which can be employed late next year when the hospital enters into contracting procedures for the OB-GYN component of the PRIMIS clinic. In order to demonstrate the model's usefulness, an attempt was made to gather as much realistic data as possible on demand for service, civilian prices for comperable care, and the availability of staff physician resources. Reliable data was easily obtained in all areas but the estimation of demand for appointments.

The comparison of CHAMPUS claims data with the volumn of appointment requests made to the OB-GYN clinic showed that CHAMPUS accounted for a small portion of the demand to be satisfied. Neither the CHAMPUS summary reports, nor a detailed CHAMPUS claims review such as the one conducted for this study, produced a reliable estimate to plan for the amount of OB-GYN clinic services which had to be provided. It was also learned that the Army's workload reporting system could only be used as an estimate of the minimum workload to be satisfied, since it did not account for requests in excess of available appointments. Whether or not the LPM is adopted in planning and managing for augmentation of staff physicians, a procedure to account for unsatisfied demand is needed. After the attempt to use CHAMPUS and the standard Army workload accounting data failed to produce a sufficient measure of total demand, a prospective recording of appointment requests for the OB-GYN clinic was made for one month. This method indicated far more demand than the CHAMPUS data or the clinic's workload data. Although the LPM can be employed without using prospectively recorded demand data, the effectiveness of the model will be enhanced with more accurate data. Finally, the ability to develop or implement a case-mix management system has been made possible by the increased access to computers by middle and lower level management personnel. The decision to adopt the case-mix model developed in this study will also require the acceptance of automated decision-making aids in the daily practice of management.

Recommendations

A recommendation has been made to the OB-GYN clinic to record the number of requests for appointments which were not able to be satisfied. This information will be of great importance in planning for the extent of augmentation by a civilian contractor. It was also recommended that the OB-GYN clinic perform the appointment scheduling for the OB-GYN component of the PRIMIS clinic. This study demonstrated the effect case-mix could have on the costs of reimbursing a contractor. The scheduling of appointments for both the OB-GYN clinic staff and the OB-GYN contract physicians could ensure patients obtained the earliest appointment available, ensure effective use of staff physicians, and reduce the costs of contracting the services.

FOOTNOTES

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[22]Op. Cit. Fetter, et.al. p. 5.

[23]CPT Paul Mouritson, PRIMIS Project Office, Office of the U. S. Army Surgeon General, in a PRIMIS briefing at Silas B. Hays Army Community Hospital, Dec 1985.

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[25]CPT Paul Mouritson, PRIMIS Project Officer, Office of the U. S. Army Surgeon General, in an Information Paper, "PRIMIS at Fort Ord" 17 Dec 85.

APPENDIX A

DEFINITIONS

APPENDIX A

Definitions

CAD: Catchment Area Demonstration Project, a CHAMPUS test project at Fort Ord designed to allow the hospital commander to explore alternative delivery systems and reduce CHAMPUS costs. The project began in March, 1984, and lost funding in December, 1985.

PRIMIS: Primary Care for the Uniformed Services. A concept of using a civilian contractor to establish and operate a primary care outpatient clinic for patients entitled to military health benefits.

CASE-MIX: A classification of patient care workload grouped by category of payment, severity of condition, consumption of resources, or other criteria, manageable product lines for planning, budgeting and reimbursement purposes.

LPM: Linear Programing Model; a linear programing formulation designed to maximize a value or minimize a value, using an automated process based on the SIMPLEX technique.

CMRIS: Computerized Medical Record Information System. An automated appointment and outpatient record system used in the OB-GYN clinic. The system captures clinical and administrative data concerning patient encounters.

CASE-MIX GROUP ABBREVIATIONS:

PAP: Pap Smear
NOB: New Obstetrical Visit
ROB: Routine Obstetrical Visit
GYN: Gynecological Visit
PPV: Postpartum/Postoperative Visit
CPC: Colposcopy
UL: Ultrasound
COB: Complicated Obstetrical Visit
HSG: Histosalpingogram

LINDO: Linear, Interactive, Discreet Optimizer; a computer program by LINDO Systems, Inc., used to run the linear programing formulations in this study.

APPENDIX B

SAMPLE LINDO REPORT

APPENDIX B
SAMPLE LINDO REPORT

Coefficients in the objective function represent the cost per visit if performed by contract physicians.

```
MAX      [illegible] Y1 + 43 Y2 + [illegible] Y3 + 43 Y4 + [illegible] Y5 + 76 Y6 + 87 Y7 + 43 Y8
   + 98 Y9
SUBJECT TO
     2)   Y1  >=   50
     3)   Y2  >=   80
     4)   Y3  >=   400
     5)   Y4  >=   [illegible]
     6)   Y5  >=   20
     7)   Y6  >=   [illegible]
     8)   Y7  >=   8
     9)   Y8  >=   [illegible]
    10)   Y9  >=   [illegible]
    11)   [illegible]
    12)   Y2  <=   [illegible]
    13)   Y3  <=   [illegible]
    14)   Y4  <=   796
    15)   Y5  <=   288
    16)   Y6  <=   69
    17)   Y7  <=   13
    18)   Y8  <=   614
    19)   Y9  <=   5
    20)   15 Y1 + 20 Y2 + [illegible] Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + [illegible] Y8
   + 30 Y9  <=   39133
```

Right hand values of rows 2 thru 10 are the minimum cases to be allocated to staff physicians.

Right hand values of rows 11 thru 19 represent total number of visits (demand) to be allocated.

Coefficients in row 20 are the number of minutes needed per visit; the right hand value is the ~~number of staff physician minutes~~ available.

```
: go
LP OPTIMUM FOUND  AT STEP     15

       OBJECTIVE FUNCTION VALUE

 1)        79511.4500 *

VARIABLE        VALUE          REDUCED COST
     Y1       50.000000          .000000
     Y2      292.000000          .000000
     Y3      400.000000          .000000
     Y4      674.150000          .000000
     Y5       20.000000          .000000
     Y6       69.000000          .000000
     Y7       13.000000          .000000
     Y8      614.000000          .000000
     Y9        5.000000          .000000

NO. ITERATIONS=      15

DO RANGE(SENSITIVITY) ANALYSIS?
? y
```

SOLUTION: The values column represents the number of visits to be allocated to staff physicians.

* equals cost savings by using staff vs. total contracting.

Case-Mix Variables

Variable	Case-Mix Group
Y1	Pap Smear
Y2	New Obstetrical
Y3	Routine Obstetrical
Y4	Gynecological
Y5	Postpartum/Operative
Y6	Colposcopy
Y7	Ultrasound
Y8	Complicated Obstetrical
Y9	Histosalpingogram

```
RANGES IN WHICH THE BASIS IS UNCHANGED:

                          OBJ COEFFICIENT RANGES
VARIABLE        CURRENT         ALLOWABLE         ALLOWABLE
                 COEF           INCREASE          DECREASE
     Y1       10.000000        22.250000          INFINITY
     Y2       43.000000         INFINITY           .000000
     Y3       10.000000        11.500000          INFINITY
     Y4       43.000000          .000000         33.000000
     Y5       10.000000        22.250000          INFINITY
     Y6       76.000000         INFINITY         11.500000
     Y7       87.000000         INFINITY         44.000000
     Y8       43.000000         INFINITY           .000000
     Y9       98.000000         INFINITY         33.500000

                          RIGHTHAND SIDE RANGES
    ROW         CURRENT         ALLOWABLE         ALLOWABLE
                  RHS           INCREASE          DECREASE
      2       50.000000       632.000000         50.000000
      3       80.000000       212.000000          INFINITY
      4      400.000000       620.000000        [illegible]
      5      [illegible]      474.150000          INFINITY
      6      [illegible]      168.000000        [illegible]
 -More--
      7      [illegible]      [illegible]         INFINITY
      8      [illegible]      [illegible]         INFINITY
      9      [illegible]      [illegible]         INFINITY
     10      [illegible]         .000000          INFINITY
     11      [illegible]       INFINITY         [illegible]
     12      [illegible]      [illegible]       [illegible]
     13      [illegible]       INFINITY         [illegible]
     14      [illegible]       INFINITY         [illegible]
     15      [illegible]       INFINITY         [illegible]
     16      [illegible]      [illegible]       [illegible]
     17      [illegible]      [illegible]       [illegible]
     18      [illegible]      [illegible]       [illegible]
     19      [illegible]      [illegible]       [illegible]
     20      [illegible]      [illegible]       [illegible]
```

APPENDIX C

ABBREVIATED LINDO SOLUTION REPORT,

FEE FOR SERVICE WITH NOV 85 DEMAND AND RESOURCES

APPENDIX C

```
MAX      10 Y1 + 43 Y2 + 10 Y3 + 43 Y4 + 10 Y5 + 76 Y6 + 87 Y7 + 43 Y8
     + 98 Y9
SUBJECT TO
        2)   Y1 >=   50
        3)   Y2 >=   80
        4)   Y3 >=   400
        5)   Y4 >=   200
        6)   Y5 >=   20
        7)   Y6 >=   49
        8)   Y7 >=   8
        9)   Y8 >=   254
       10)   Y9 >=   5
       11)   Y1 <=   824
       12)   Y2 <=   292
       13)   Y3 <=   1020
       14)   Y4 <=   796
       15)   Y5 <=   288
       16)   Y6 <=   69
       17)   Y7 <=   13
       18)   Y8 <=   614
       19)   Y9 <=   5
       20)   15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
     + 30 Y9 <=   21853
LP OPTIMUM FOUND  AT STEP     14

         OBJECTIVE FUNCTION VALUE

 1)         42359.4500

 VARIABLE        VALUE          REDUCED COST
       Y1        50.000000          .000000
       Y2       262.150000          .000000
       Y3       400.000000          .000000
       Y4       200.000000          .000000
       Y5        20.000000          .000000
       Y6        69.000000          .000000
       Y7        13.000000          .000000
       Y8       254.000000          .000000
       Y9         5.000000          .000000


NO. ITERATIONS=       14

DO RANGE(SENSITIVITY) ANALYSIS?
? y

RANGES IN WHICH THE BASIS IS UNCHANGED:

                          OBJ COEFFICIENT RANGES
VARIABLE         CURRENT        ALLOWABLE        ALLOWABLE
                  COEF          INCREASE         DECREASE
      Y1        10.000000       22.250000        INFINITY
      Y2        43.000000        7.666667          .000000
      Y3        10.000000       11.500000        INFINITY
      Y4        43.000000         .000000        INFINITY
      Y5        10.000000       22.250000        INFINITY
      Y6        76.000000       INFINITY         11.500000
      Y7        87.000000       INFINITY         44.000000
      Y8        43.000000         .000000        INFINITY
      Y9        98.000000       INFINITY         33.500000


                          RIGHTHAND SIDE RANGES
    ROW          CURRENT        ALLOWABLE        ALLOWABLE
                   RHS          INCREASE         DECREASE
       2        50.000000      242.866700        39.800000
       3        80.000000      182.150000        INFINITY
       4       400.000000      364.300000        59.700000
       5       200.000000      182.150000        29.850000
       6        20.000000      242.866700        20.000000
--More--
       7        49.000000       20.000000        INFINITY
       8         8.000000        5.000000        INFINITY
       9       254.000000      132.150000        29.850000
      10         5.000000         .000000        INFINITY
      11       824.000000      INFINITY         774.000000
      12       292.000000      INFINITY          29.850000
      13      1020.000000      INFINITY         620.000000
      14       796.000000      INFINITY         596.000000
      15       288.000000      INFINITY         268.000000
      16        69.000000      121.433300        19.900000
      17        13.000000      182.150000         5.000000
      18       614.000000      INFINITY         360.000000
      19         5.000000      121.433300          .000000
      20     21853.000000      597.000000      3643.000000
```

APPENDIX D

ABBREVIATED LINDO SOLUTION REPORT,

$100 HOURLY RATE, WITH NOV 85 DEMAND AND RESOURCES

APPENDIX D

```
MAX      25 Y1 + 33 Y2 + 17 Y3 + 33 Y4 + 25 Y5 + 50 Y6 + 33 Y7 + 33 Y8
     + 50 Y9
SUBJECT TO
        2)    Y1 >=    50
        3)    Y2 >=    80
        4)    Y3 >=    400
        5)    Y4 >=    200
        6)    Y5 >=    20
        7)    Y6 >=    49
        8)    Y7 >=    8
        9)    Y8 >=    254
       10)    Y9 >=    5
       11)    Y1 <=    824
       12)    Y2 <=    292
       13)    Y3 <=    1020
       14)    Y4 <=    796
       15)    Y5 <=    288
       16)    Y6 <=    69
       17)    Y7 <=    13
       18)    Y8 <=    614
       19)    Y9 <=    5
       20)    15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
     + 30 Y9 <=    21853
LP OPTIMUM FOUND  AT STEP      13

        OBJECTIVE FUNCTION VALUE

 1)         35519.1000
```

VARIABLE	VALUE	REDUCED COST
Y1	50.000000	.000000
Y2	80.000000	.000000
Y3	834.300000	.000000
Y4	200.000000	.000000
Y5	20.000000	.000000
Y6	49.000000	.000000
Y7	8.000000	.000000
Y8	254.000000	.000000
Y9	5.000000	.000000

```
DO RANGE(SENSITIVITY) ANALYSIS?
? y

RANGES IN WHICH THE BASIS IS UNCHANGED:
```

OBJ COEFFICIENT RANGES

VARIABLE	CURRENT COEF	ALLOWABLE INCREASE	ALLOWABLE DECREASE
Y1	25.000000	.500000	INFINITY
Y2	33.000000	1.000000	INFINITY
Y3	17.000000	INFINITY	.333333
Y4	33.000000	1.000000	INFINITY
Y5	25.000000	.500000	INFINITY
Y6	50.000000	1.000000	INFINITY
Y7	33.000000	1.000000	INFINITY
Y8	33.000000	1.000000	INFINITY
Y9	50.000000	1.000000	INFINITY

RIGHTHAND SIDE RANGES

ROW	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	50.000000	289.533300	50.000000
3	80.000000	212.000000	80.000000
4	400.000000	434.300000	INFINITY
5	200.000000	217.150000	92.850000
6	20.000000	268.000000	20.000000
--More--			
7	49.000000	20.000000	49.000000
8	8.000000	5.000000	8.000000
9	254.000000	217.150000	92.850000
10	5.000000	.000000	5.000000
11	824.000000	INFINITY	774.000000
12	292.000000	INFINITY	212.000000
13	1020.000000	INFINITY	185.700000
14	796.000000	INFINITY	596.000000
15	288.000000	INFINITY	268.000000
16	69.000000	INFINITY	20.000000
17	13.000000	INFINITY	5.000000
18	614.000000	INFINITY	360.000000
19	5.000000	INFINITY	.000000
20	21853.000000	[illegible]57.000000	4343.000000

APPENDIX E

ABBREVIATED LINDO SOLUTION REPORT, FLAT FEE,

WITH NOV 85 DEMAND AND RESOURCES

APPENDIX E

```
MAX      50.14 Y1 + 50.14 Y2 + 50.14 Y3 + 50.14 Y4 + 50.14 Y5 + 50.14 Y6
    + 50.14 Y7 + 50.14 Y8 + 50.14 Y9
SUBJECT TO
       2)   Y1 >=   50
       3)   Y2 >=   80
       4)   Y3 >=   400
       5)   Y4  =   200
       6)   Y5 >=   20
       7)   Y6 >=   49
       8)   Y7 >=   8
       9)   Y8 >=   254
      10)   Y9 >=   5
      11)   Y1 <=   324
      12)   Y2 <=   292
      13)   Y3 <=   1028
      14)   Y4 <=   796
      15)   Y5 <=   298
      16)   Y6 <=   69
      17)   Y7 <=   13
      18)   Y8 <=   614
      19)   Y9 <=   5
      20)   15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
    + 30 Y9 <=   21835
LP OPTIMUM FOUND  AT STEP      3

        OBJECTIVE FUNCTION VALUE

 1)         75134.7900

 VARIABLE          VALUE          REDUCED COST
       Y1        50.000000           .000000
       Y2        80.000000           .000000
       Y3       332.500000           .000000
       Y4       200.000000           .000000
       Y5        20.000000           .000000
       Y6        49.000000           .000000
       Y7         8.000000           .000000
       Y8       254.000000           .000000
       Y9         5.000000           .000000

NO. ITERATIONS=        3

DO RANGE(SENSITIVITY) ANALYSIS?
? y

RANGES IN WHICH THE BASIS IS UNCHANGED:

                              OBJ COEFFICIENT RANGES
VARIABLE          CURRENT        ALLOWABLE          ALLOWABLE
                   COEF          INCREASE           DECREASE
      Y1        50.140000        25.070000          INFINITY
      Y2        50.140000        50.140000          INFINITY
      Y3        50.140000        INFINITY           16.713330
      Y4        50.140000        50.140000          INFINITY
      Y5        50.140000        25.070000          INFINITY
      Y6        50.140000       100.280000          INFINITY
      Y7        50.140000        50.140000          INFINITY
      Y8        50.140000        50.140000          INFINITY
      Y9        50.140000       100.280000          INFINITY

                              RIGHTHAND SIDE RANGES
     ROW          CURRENT        ALLOWABLE          ALLOWABLE
                    RHS          INCREASE           DECREASE
       2        50.000000       288.333300          50.000000
       3        80.000000       212.000000          80.000000
       4       400.000000       432.500000          INFINITY
       5       200.000000       216.250000          93.750000
       6        20.000000       268.000000          20.000000
--More--
       7        49.000000        20.000000          49.000000
       8         8.000000         5.00000           8.000000
       9       254.000000       216.[illegible]     93.[illegible]
      10         5.000000          .000000           5.[illegible]
      11       [illegible]4.000000 INFINITY         [illegible]
      12       [illegible]2.000000 INFINITY         [illegible].000000
      13       [illegible]           INFINITY         [illegible]
      14       [illegible].000000  INFINITY          596.000000
      15       [illegible]         INFINITY          25[illegible]
      16        [illegible]9.000000 INFINITY         20.000000
      17       [illegible]          [illegible]       [illegible]
      18       [illegible]4.000000  INFINITY         350.[illegible]
      19       [illegible]          INFINITY         [illegible]
      20       [illegible]35.[illegible] [illegible].000000 [illegible]25.[illegible]
```

APPENDIX F

ABBREVIATED LINDO SOLUTION REPORT, FEE FOR SERVICE,

WITH NOV 85 DEMAND AND SEP 85 STAFFING

APPENDIX F

```
MAX      10 Y1 + 43 Y2 + 10 Y3 + 43 Y4 + 10 Y5 + 76 Y6 + 87 Y7 + 43 Y8
     + 98 Y9
SUBJECT TO
        2)    Y1  >=   50
        3)    Y2  >=   80
        4)    Y3  >=   400
        5)    Y4  >=   200
        6)    Y5  >=   20
        7)    Y6  >=   49
        8)    Y7  >=   8
        9)    Y8  >=   254
       10)    Y9  >=   5
       11)    Y1  <=   924
       12)    Y2  <=   292
       13)    Y3  <=   1020
       14)    Y4  <=   796
       15)    Y5  <=   288
       16)    Y6  <=   69
       17)    Y7  <=   13
       18)    Y8  <=   614
       19)    Y9  <=   5
       20)    15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
     + 30 Y9 <=   47300
LP OPTIMUM FOUND  AT STEP      3

         OBJECTIVE FUNCTION VALUE

  1)          90481.0000

 VARIABLE          VALUE            REDUCED COST
       Y1          50.000000            .000000
       Y2         292.000000            .000000
       Y3         973.000000            .000000
       Y4         796.000000            .000000
       Y5          20.000000            .000000
       Y6          69.000000            .000000
       Y7          13.000000            .000000
       Y8         614.000000            .000000
       Y9           5.000000            .000000

NO. ITERATIONS=       3

DO RANGE(SENSITIVITY) ANALYSIS?
? y


RANGES IN WHICH THE BASIS IS UNCHANGED:

                              OBJ COEFFICIENT RANGES
VARIABLE          CURRENT         ALLOWABLE         ALLOWABLE
                   COEF           INCREASE          DECREASE
      Y1         10.000000         5.000000         INFINITY
      Y2         43.000000        INFINITY          23.000000
      Y3         10.000000        11.500000          3.333333
      Y4         43.000000        INFINITY          23.000000
      Y5         10.000000         5.000000         INFINITY
      Y6         76.000000        INFINITY          46.000000
      Y7         87.000000        INFINITY          67.000000
      Y8         43.000000        INFINITY          23.000000
      Y9         98.000000        INFINITY          68.000000


                              RIGHTHAND SIDE RANGES
     ROW          CURRENT         ALLOWABLE         ALLOWABLE
                    RHS           INCREASE          DECREASE
       2         50.000000       382.000000         31.333330
       3         80.000000       212.000000        INFINITY
       4        400.000000       573.000000        INFINITY
       5        200.000000       596.000000        INFINITY
       6         20.000000       268.000000         20.000000
--More--
       7         49.000000        20.000000        INFINITY
       8          8.000000         5.000000        INFINITY
       9        254.000000       360.000000        INFINITY
      10          5.000000          .000000        INFINITY
      11        924.000000       INFINITY          774.000000
      12        292.000000       286.500000         23.500000
      13       1020.000000       INFINITY           47.000000
      14        796.000000       286.500000         23.500000
      15        288.000000       INFINITY          268.000000
      16         69.000000       191.000000         15.666670
      17         13.000000       286.500000          5.000000
      18        614.000000       286.500000         23.500000
      19          5.000000       191.000000           .000000
      20       47300.00000       470.000000       5770.000000
```

APPENDIX G

ABBREVIATED LINDO SOLUTION REPORT, $100 HOURLY RATE,

WITH NOV 85 DEMAND AND SEP 85 STAFFING

APPENDIX G

```
MAX      25 Y1 + 33 Y2 + 17 Y3 + 33 Y4 + 25 Y5 + 50 Y6 + 33 Y7 + 33 Y8
   + 50 Y9
SUBJECT TO
        2)    Y1 >=   50
        3)    Y2 >=   80
        4)    Y3 >=   400
        5)    Y4 >=   200
        6)    Y5 >=   20
        7)    Y6 >=   49
        8)    Y7 >=   8
        9)    Y8 >=   254
       10)    Y9 >=   5
       11)    Y1 <=   824
       12)    Y2 <=   292
       13)    Y3 <=   1020
       14)    Y4 <=   796
       15)    Y5 <=   288
       16)    Y6 <=   69
       17)    Y7 <=   13
       18)    Y8 <=   614
       19)    Y9 <=   5
       20)    15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
   + 30 Y9 <=   47300
LP OPTIMUM FOUND  AT STEP      7

        OBJECTIVE FUNCTION VALUE

 1)         78870.0000
```

VARIABLE	VALUE	REDUCED COST
Y1	824.000000	.000000
Y2	80.000000	.000000
Y3	1020.000000	.000000
Y4	203.000000	.000000
Y5	288.000000	.000000
Y6	69.000000	.000000
Y7	13.000000	.000000
Y8	614.000000	.000000
Y9	5.000000	.000000

NO. ITERATIONS= 7

DO RANGE(SENSITIVITY) ANALYSIS?
? y

RANGES IN WHICH THE BASIS IS UNCHANGED:

OBJ COEFFICIENT RANGES

VARIABLE	CURRENT COEF	ALLOWABLE INCREASE	ALLOWABLE DECREASE
Y1	25.000000	INFINITY	.250000
Y2	33.000000	.000000	INFINITY
Y3	17.000000	INFINITY	.500000
Y4	33.000000	.000000	.000000
Y5	25.000000	INFINITY	.250000
Y6	50.000000	INFINITY	.500000
Y7	33.000000	INFINITY	.000000
Y8	33.000000	INFINITY	.000000
Y9	50.000000	INFINITY	.500000

RIGHTHAND SIDE RANGES

ROW	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	50.000000	774.000000	INFINITY
3	80.000000	3.000000	80.000000
4	400.000000	620.000000	INFINITY
5	200.000000	3.000000	INFINITY
6	20.000000	268.000000	INFINITY
--More--			
7	49.000000	20.000000	INFINITY
8	8.000000	5.000000	INFINITY
9	254.000000	360.000000	INFINITY
10	5.000000	.000000	INFINITY
11	824.000000	4.000000	774.000000
12	292.000000	INFINITY	212.000000
13	1020.000000	3.000000	620.000000
14	796.000000	INFINITY	593.000000
15	288.000000	4.000000	268.000000
16	69.000000	2.000000	20.000000
17	13.000000	[illegible]	5.000000
18	614.000000	[illegible]	360.000000
19	[illegible]	2.000000	[illegible]
20	47300.000000	11860.000000	[illegible]

APPENDIX H

ABBREVIATED LINDO SOLUTION REPORT, FLAT FEE, WITH NOV 85 DEMAND AND SEP 85 STAFFING

APPENDIX H

```
MAX     50.14 Y1 + 50.14 Y2 + 50.14 Y3 + 50.14 Y4 + 50.14 Y5 + 50.14 Y6
    + 50.14 Y7 + 50.14 Y8 + 50.14 Y9
SUBJECT TO
        2)   Y1 >=   50
        3)   Y2 >=   80
        4)   Y3 >=   400
        5)   Y4 >=   200
        6)   Y5 >=   20
        7)   Y6 >=   49
        8)   Y7 >=   8
        9)   Y8 >=   254
       10)   Y9 >=   5
       11)   Y1 <=   824
       12)   Y2 <=   292
       13)   Y3 <=   1020
       14)   Y4 <=   796
       15)   Y5 <=   288
       16)   Y6 <=   69
       17)   Y7 <=   13
       18)   Y8 <=   614
       19)   Y9 <=   5
       20)   15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
    + 30 Y9 <=   47300
: go
LP OPTIMUM FOUND  AT STEP      5

         OBJECTIVE FUNCTION VALUE

  1)          156737.700

 VARIABLE          VALUE             REDUCED COST
        Y1       824.000000            .000000
        Y2        80.000000            .000000
        Y3      1020.000000            .000000
        Y4       233.000000            .000000
        Y5       288.000000            .000000
        Y6        49.000000            .000000
        Y7        13.000000            .000000
        Y8       614.000000            .000000
        Y9         5.000000            .000000

DO RANGE(SENSITIVITY) ANALYSIS?
? y

RANGES IN WHICH THE BASIS IS UNCHANGED:

                              OBJ COEFFICIENT RANGES
VARIABLE          CURRENT          ALLOWABLE          ALLOWABLE
                   COEF            INCREASE           DECREASE
       Y1        50.140000         INFINITY          12.535000
       Y2        50.140000          .000000          INFINITY
       Y3        50.140000         INFINITY          25.070000
       Y4        50.140000          .000000           .000000
       Y5        50.140000         INFINITY          12.535000
       Y6        50.140000         25.070000         INFINITY
       Y7        50.140000         INFINITY           .000000
       Y8        50.140000         INFINITY           .000000
       Y9        50.140000         25.070000         INFINITY

                              RIGHTHAND SIDE RANGES
      ROW         CURRENT          ALLOWABLE          ALLOWABLE
                    RHS            INCREASE           DECREASE
        2        50.000000        774.000000         INFINITY
        3        30.000000         33.000000         80.000000
        4       400.000000        620.000000         INFINITY
        5       200.000000        [illegible]        INFINITY
        6        20.000000        268.000000         INFINITY
--More--
        7        49.000000         20.000000        [illegible]
        8         8.000000          5.000000         INFINITY
        9       254.000000        360.000000         INFINITY
       10         5.000000           .000000          5.000000
       11       824.000000        [illegible]       750.666700
       12       292.000000         INFINITY         212.000000
       13       [illegible]       [illegible]       [illegible]
       14       796.000000         INFINITY         563.000000
       15       [illegible]       [illegible]       [illegible]
       16        69.000000         INFINITY         [illegible]
       17       [illegible]       [illegible]       [illegible]
       18       [illegible]       [illegible]       [illegible]
       19       [illegible]        INFINITY         [illegible]
       20       [illegible]       [illegible]       [illegible]
```

APPENDIX I

ABBREVIATED LINDO SOLUTION REPORT, FEE FOR SERVICE,

WITH NOV 85 DEMAND, NOV 85 STAFFING AND TWO FTE'S

APPENDIX I

```
MAX      10 Y1 + 43 Y2 + 10 Y3 + 43 Y4 + 10 Y5 + 76 Y6 + 87 Y7 + 43 Y8
     + 98 Y9
SUBJECT TO
           2)    Y1 >=    50
           3)    Y2 >=    80
           4)    Y3 >=    400
           5)    Y4 >=    200
           6)    Y5 >=    20
           7)    Y6 >=    49
           8)    Y7 >=    8
           9)    Y8 >=    254
          10)    Y9 >=    5
          11)    Y1 <=    324
          12)    Y2 <=    292
          13)    Y3 <=    1020
          14)    Y4 <=    796
          15)    Y5 <=    288
          16)    Y6 <=    69
          17)    Y7 <=    13
          18)    Y8 <=    614
          19)    Y9 <=    5
          20)    15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
       + 30 Y9 <=    39133
: go
LP OPTIMUM FOUND  AT STEP     15

        OBJECTIVE FUNCTION VALUE

 1)         79511.4500

 VARIABLE          VALUE           REDUCED COST
       Y1         50.000000           .000000
       Y2        292.000000           .000000
       Y3        400.000000           .000000
       Y4        674.150000           .000000
       Y5         20.000000           .000000
       Y6         69.000000           .000000
       Y7         13.000000           .000000
       Y8        614.000000           .000000
       Y9          5.000000           .000000
NO. ITERATIONS=       15

DO RANGE(SENSITIVITY) ANALYSIS?
? y

RANGES IN WHICH THE BASIS IS UNCHANGED:

                              OBJ COEFFICIENT RANGES
VARIABLE          CURRENT         ALLOWABLE          ALLOWABLE
                   COEF           INCREASE           DECREASE
      Y1        10.000000        22.250000          INFINITY
      Y2        43.000000        INFINITY             .000000
      Y3        10.000000        11.500000          INFINITY
      Y4        43.000000          .000000           23.000000
      Y5        10.000000        22.250000          INFINITY
      Y6        76.000000        INFINITY            11.500000
      Y7        87.000000        INFINITY            44.000000
      Y8        43.000000        INFINITY              .000000
      Y9        98.000000        INFINITY            33.500000


                              RIGHTHAND SIDE RANGES
     ROW          CURRENT         ALLOWABLE          ALLOWABLE
                    RHS           INCREASE           DECREASE
       2        50.000000       632.200000          50.000000
       3        80.000000       212.000000          INFINITY
       4       400.000000       620.000000         243.700000
       5       200.000000       474.150000          INFINITY
       6        20.000000       268.000000          20.000000
--More--
       7       [illegible]      [illegible]0.000000  INFINITY
       8         8.000000         5.000000          INFINITY
       9       254.000000       260.000000          INFINITY
      10         5.000000          .000000          INFINITY
      11       324.000000       INFINITY           274.000000
      12       292.000000       474.150000         121.850000
      13      1020.000000       INFINITY           620.000000
      14       796.000000       INFINITY           121.350000
      15       288.000000       INFINITY           268.000000
      16        69.00000        316.[illegible]     20.000000
      17        13.000000      [illegible]         [illegible]
      18       614.000000       474.150000         121.85[illegible]
      19       [illegible]      5[illegible]        [illegible]
      20     39133.000000      2437.000000         [illegible]
```

APPENDIX J

ABBREVIATED LINDO SOLUTION REPORT, FLAT FEE,

WITH NOV 85 DEMAND, NOV 85 STAFFING AND TWO FTE'S

APPENDIX J

```
MAX     25 Y1 + 33 Y2 + 17 Y3 + 33 Y4 + 25 Y5 + 50 Y6 + 33 Y7 + 33 Y8
     + 50 Y9
SUBJECT TO
        2)    Y1 >=    50
        3)    Y2 >=    80
        4)    Y3 >=    400
        5)    Y4 >=    200
        6)    Y5 >=    20
        7)    Y6 >=    49
        8)    Y7 >=    8
        9)    Y8 >=    254
       10)    Y9 >=    5
       11)    Y1 <=    824
       12)    Y2 <=    292
       13)    Y3 <=    1020
       14)    Y4 <=    796
       15)    Y5 <=    288
       16)    Y6 <=    69
       17)    Y7 <=    13
       18)    Y8 <=    614
       19)    Y9 <=    5
       20)    15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
     + 30 Y9 <=   39133
: go
LP OPTIMUM FOUND  AT STEP      3

        OBJECTIVE FUNCTION VALUE

 1)          65331.0000

 VARIABLE         VALUE             REDUCED COST
       Y1        824.000000            .000000
       Y2         80.000000            .000000
       Y3       1020.000000            .000000
       Y4        200.000000            .000000
       Y5        234.200000            .000000
       Y6         69.000000            .000000
       Y7          8.000000            .000000
       Y8        254.000000            .000000
       Y9          5.000000            .000000
NO. ITERATIONS=         3

DO RANGE(SENSITIVITY) ANALYSIS?
? y

RANGES IN WHICH THE BASIS IS UNCHANGED:

                          OBJ COEFFICIENT RANGES
VARIABLE          CURRENT          ALLOWABLE         ALLOWABLE
                   COEF            INCREASE          DECREASE
      Y1         25.000000         INFINITY           .000000
      Y2         33.000000          .333332          INFINITY
      Y3         17.000000         INFINITY           .333334
      Y4         33.000000          .333332          INFINITY
      Y5         25.000000          .000000           .249999
      Y6         50.000000         INFINITY           .000000
      Y7         33.000000          .333332          INFINITY
      Y8         33.000000          .333332          INFINITY
      Y9         50.000000         INFINITY           .000000

                          RIGHTHAND SIDE RANGES
     ROW          CURRENT          ALLOWABLE         ALLOWABLE
                    RHS            INCREASE          DECREASE
       2         50.000000        774.000000         INFINITY
       3         80.000000        160.650000         40.350000
       4        400.000000        620.000000         INFINITY
       5        [illegible]0.000000  [illegible]50.650000   40.350000
       6         20.000000        214.200000         INFINITY
--More--
       7         49.000000         20.000000         INFINITY
       8          8.000000          5.000000         9.000000
       9        254.000000        160.650000         40.350000
      10          5.000000           .000000         INFINITY
      11        824.000000        114.200000         53.300000
      12        292.000000         INFINITY          [illegible]2.000000
      13       1020.000000        [illegible]        [illegible]
      14        795.000000         INFINITY          596.000000
      15        288.000000         INFINITY          53.900000
      16        [illegible]9.000000  [illegible]7.100000   20.000000
      17        [illegible]         INFINITY          5.000000
      18        614.000000         INFINITY          [illegible]60.000000
      19        [illegible]        [illegible]        [illegible]
      20        [illegible]33.000000  [illegible]6.999[illegible]  [illegible]
```

APPENDIX K

ABBREVIATED LINDO SOLUTION REPORT, FLAT FEE,

WITH NOV 85 DEMAND, NOV 85 STAFFING AND TWO FTE'S

APPENDIX K

```
MAX      50.14 Y1 + 50.14 Y2 + 50.14 Y3 + 50.14 Y4 + 50.14 Y5 + 50.14 Y6
     + 50.14 Y7 + 50.14 Y8 + 50.14 Y9
SUBJECT TO
         2)     Y1 >=    50
         3)     Y2 >=   80
         4)     Y3  =    400
         5)     Y4  =    200
         6)     Y5 >=    20
         7)     Y6 >=    49
         8)     Y7  =    8
         9)     Y8 >=    254
        10)     Y9 >=    5
        11)     Y1 <=    824
        12)     Y2 <=    292
        13)     Y3 <=    1020
        14)     Y4 <=    796
        15)     Y5 <=    288
        16)     Y6 <=    69
        17)     Y7 <=    13
        18)     Y8 <=    614
        19)     Y9 <=    5
        20)     15 Y1 + 20 Y2 + 10 Y3 + 20 Y4 + 15 Y5 + 30 Y6 + 20 Y7 + 20 Y8
     + 30 Y9 <=    39133
: go
LP OPTIMUM FOUND  AT STEP      1

               OBJECTIVE FUNCTION VALUE

 1)          136090.000

 VARIABLE         VALUE              REDUCED COST
        Y1       824.000000            .000000
        Y2        80.000000            .000000
        Y3      1020.000000            .000000
        Y4       200.000000            .000000
        Y5       274.200000            .000000
        Y6        49.000000            .000000
        Y7         8.000000            .000000
        Y8       254.000000            .000000
        Y9         5.000000            .000000
NO. ITERATIONS=          1

DO RANGE(SENSITIVITY) ANALYSIS?
? y
```

RANGES IN WHICH THE BASIS IS UNCHANGED:

OBJ COEFFICIENT RANGES

VARIABLE	CURRENT COEF	ALLOWABLE INCREASE	ALLOWABLE DECREASE
Y1	50.140000	INFINITY	.000000
Y2	50.140000	16.713330	INFINITY
Y3	50.140000	INFINITY	16.713330
Y4	50.140000	16.713330	INFINITY
Y5	50.140000	.000000	12.535000
Y6	50.140000	50.140000	INFINITY
Y7	50.140000	16.713330	INFINITY
Y8	50.140000	16.713330	INFINITY
Y9	50.140000	50.140000	INFINITY

RIGHTHAND SIDE RANGES

ROW	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	50.000000	774.000000	INFINITY
3	80.000000	190.650000	10.350000
4	400.000000	620.000000	INFINITY
5	200.000000	190.650000	10.350000
6	20.000000	254.200000	INFINITY
7	49.000000	20.000000	[illegible]
8	8.000000	5.000000	[illegible]
9	254.000000	190.650000	[illegible]
10	5.000000	.000000	[illegible]
11	[illegible]	254.200000	[illegible]
12	[illegible]	INFINITY	[illegible]
13	[illegible]	[illegible]	[illegible]
14	[illegible]	INFINITY	[illegible]
15	[illegible]	INFINITY	[illegible]
16	[illegible]	INFINITY	[illegible]
17	[illegible]	INFINITY	[illegible]
18	[illegible]	INFINITY	[illegible]
19	[illegible]	INFINITY	[illegible]
20	[illegible]	[illegible]	[illegible]

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